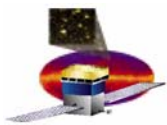


GLAST Large Area Telescope: AntiCoincidence Detector (ACD)

Critical Design Review (CDR)

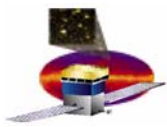
January 7 & 8, 2003



Agenda

DAY 1 – January 7

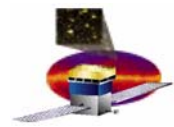
Section 1 - ACD Overview	8:30-9:15
Section 2 - ACD Management	9:15-9:50
BREAK	9:50-10:00
Section 3 - Systems Engineering	10:00-11:00
Section 4 – ACD Science	11:00-11:45
LUNCH	11:45-12:45
Section 5 - Mechanical	12:45-3:00
BREAK	3:00-3:10
Section 6 - Electrical	3:10-5:00



Agenda

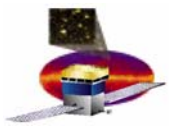
DAY 2 – January 8

Section 7 - MGSE	8:30-8:55
Section 8 - EGSE, Perf. Mon., & Calib.	8:55-9:15
Section 9 - Safety and Mission Assurance	9:15-10:00
BREAK	10:00-10:15
Section 10 - Integration and Test	10:15-11:00
Summary	11:00-11:15
Closeout	11:15-12:00



Review Board Team

- | | |
|-------------------------------|-------------------------------|
| • Dennis Dillman/301 | Review Chairman |
| • James Ryan/543 | Mechanical Engineering |
| • Steve Scott/500 | Chief Engineer |
| • Gary Sneiderman/556 | Instrument Management |
| • Fred Huegel/560 | Electrical Engineering |
| • Joseph Bolek/532 | Systems Engineering |
| • Ted Michalek/545 | Thermal Engineering |
| • Mark Goans/301 | Systems Review Office |
| • Lowell Klaisner/SLAC | LAT Chief Engineer |
| • Dick Horn/SLAC | LAT Systems Engineer |



GLAST Large Area Telescope:

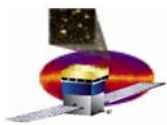
AntiCoincidence Detector (ACD)

WBS 4.1.6

Overview

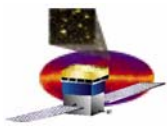
David J. Thompson, Subsystem Manager
djt@egret.gsfc.nasa.gov (301) 286-8168

NASA Goddard Space Flight Center



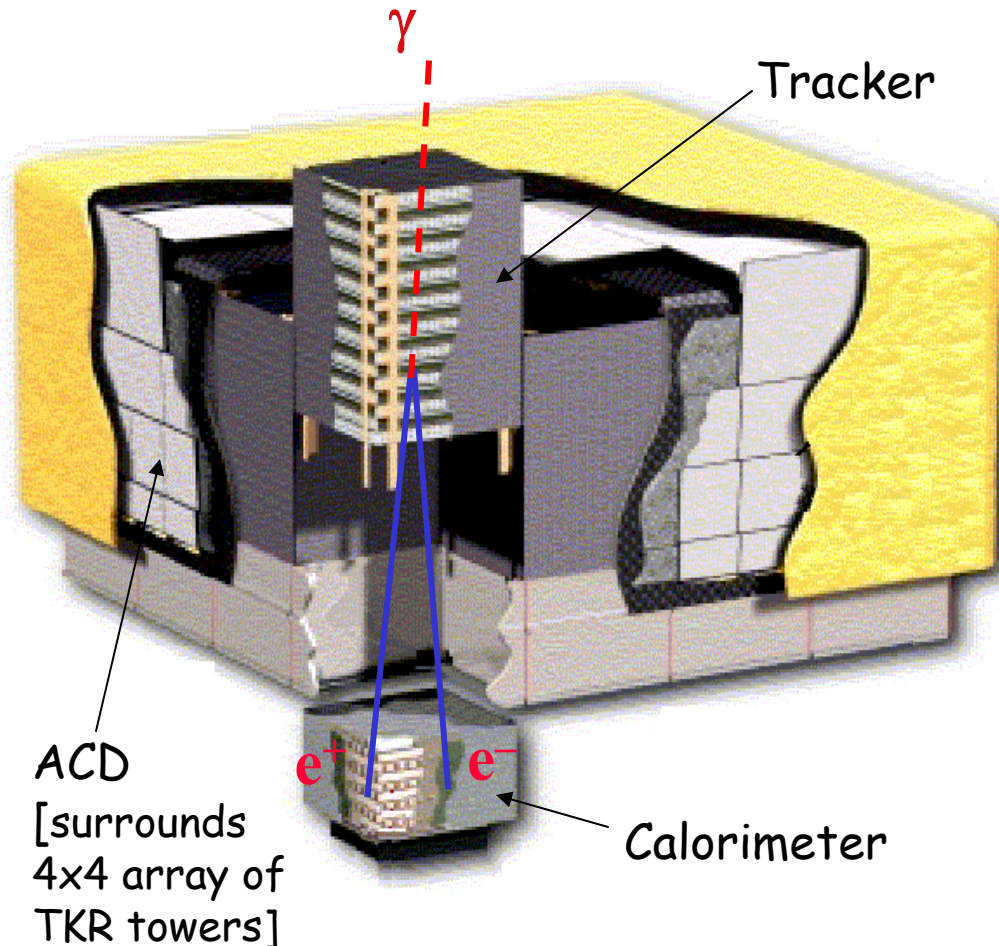
Outline

- **Overview of LAT and ACD**
- **Level III Requirements Summary**
- **Meeting Key Requirements**
- **Flowdown – Requirements to Design**
- **Design Evolution**
- **Optimization**
- **Technical Heritage**
- **Reviews – Past and Future**
- **Summary of July Δ PDR**
- **Status of January LAT PDR Recommendations**



Overview of LAT

- Precision Si-strip Tracker (TKR)
18 XY tracking planes. Single-sided silicon strip detectors (228 μm pitch)
Measure the photon direction; gamma ID.
- Hodoscopic CsI Calorimeter(CAL)
Array of 1536 CsI(Tl) crystals in 8 layers.
Measure the photon energy; image the shower.
- Segmented Anticoincidence Detector (ACD) 89 plastic scintillator tiles.
Reject background of charged cosmic rays; segmentation removes self-veto effects at high energy.
- Electronics System Includes flexible, robust hardware trigger and software filters.

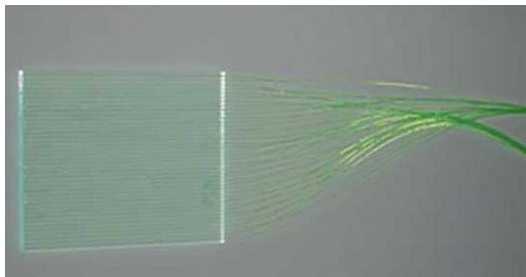


Systems work together to identify and measure the flux of cosmic gamma rays with energy 20 MeV - >300 GeV.

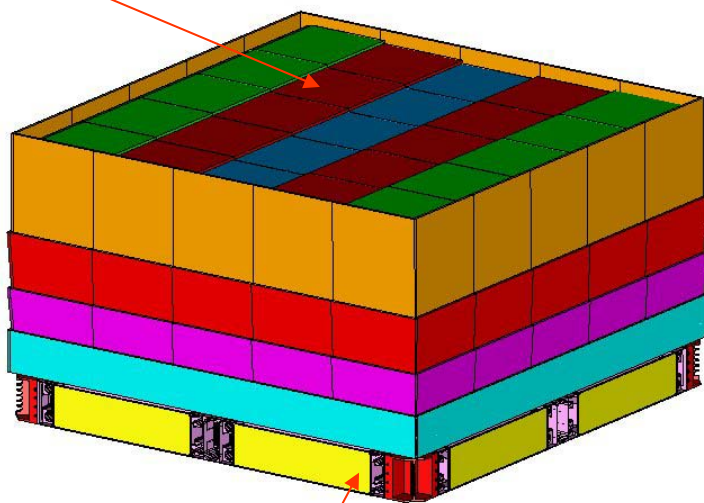


LAT Anticoincidence Detector

Prototype
ACD tile read
out with
Wavelength
Shifting Fiber



Tile Shell Assembly
(TSA)



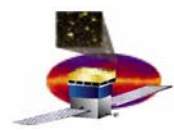
Base Electronics
Assembly (BEA)

- **TILE SHELL ASSEMBLY**

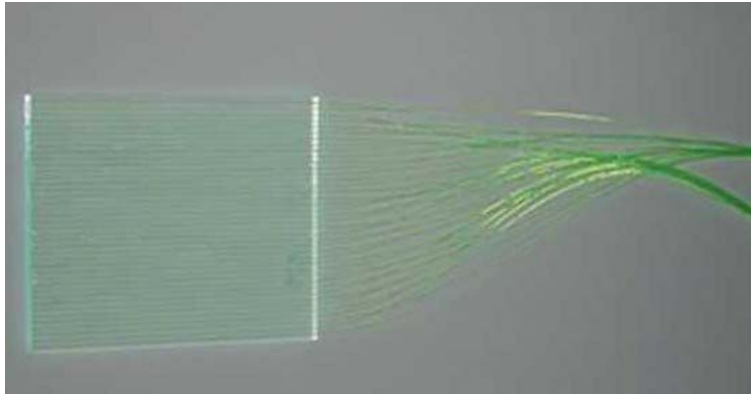
- 89 Plastic scintillator tiles
- Waveshifting fiber light collection (with clear fiber light guides for long runs)
- Two sets of fibers interleaved for each tile
- Tiles overlap in one dimension
- 8 scintillating fiber ribbons cover gaps in other dimension (not shown)
- Supported on self-standing composite shell
- Covered by thermal blanket + micrometeoroid shield (not shown)

- **BASE ELECTRONICS ASSEMBLY**

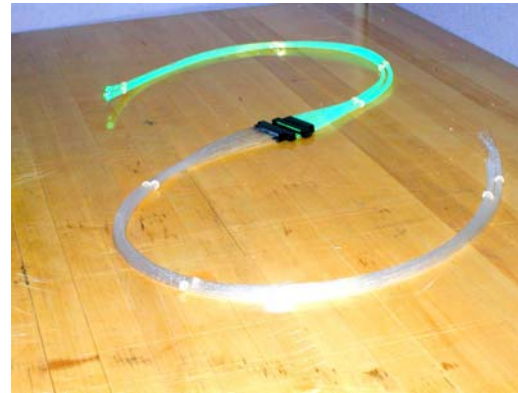
- 194 photomultiplier tube sensors (2/tile)
- 12 electronics boards (two sets of 6), each handling up to 18 phototubes. Two High Voltage Bias Supplies on each board.



ACD Tile Detector Assembly (TDA)



Scintillator tile/Waveshifting fibers



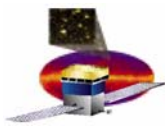
Optical connector/Clear fibers



Phototube/Resistor Network

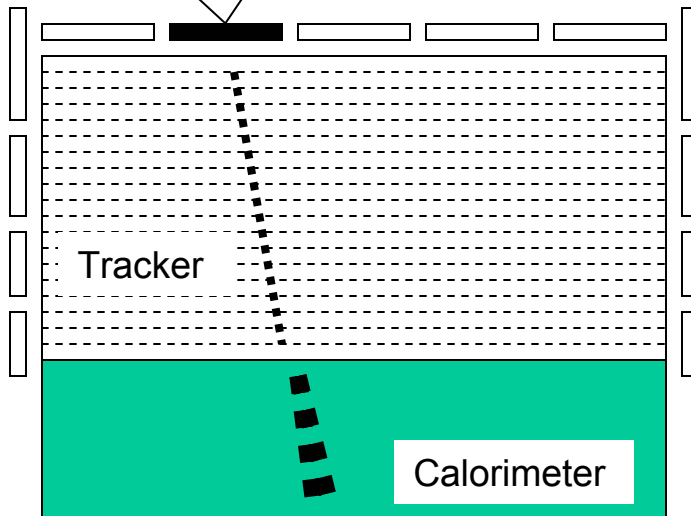
Flight-design TDAs have been successfully built, performance-tested, mounted on a flight-like composite structure, and environmentally tested to qualification levels (vibration and thermal vacuum).



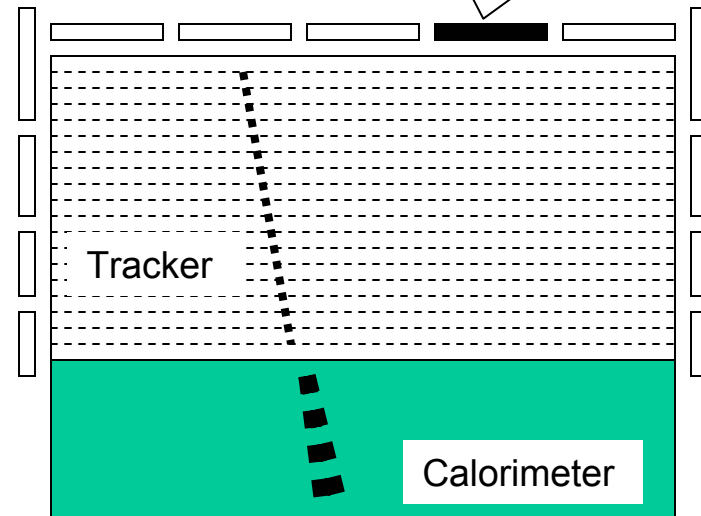


Charged Particle Detection vs. Backsplash

Charged particles produce signals lined up in the segmented ACD, TKR, CAL



A high-energy gamma ray can produce secondary photons that “splash” out of the CAL and can trigger an ACD tile.



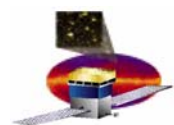
If the ACD were not segmented, we would lose the valuable high-energy gamma rays that produced a back-splash signal. This self-veto reduced the EGRET efficiency at high energies by more than 50%.



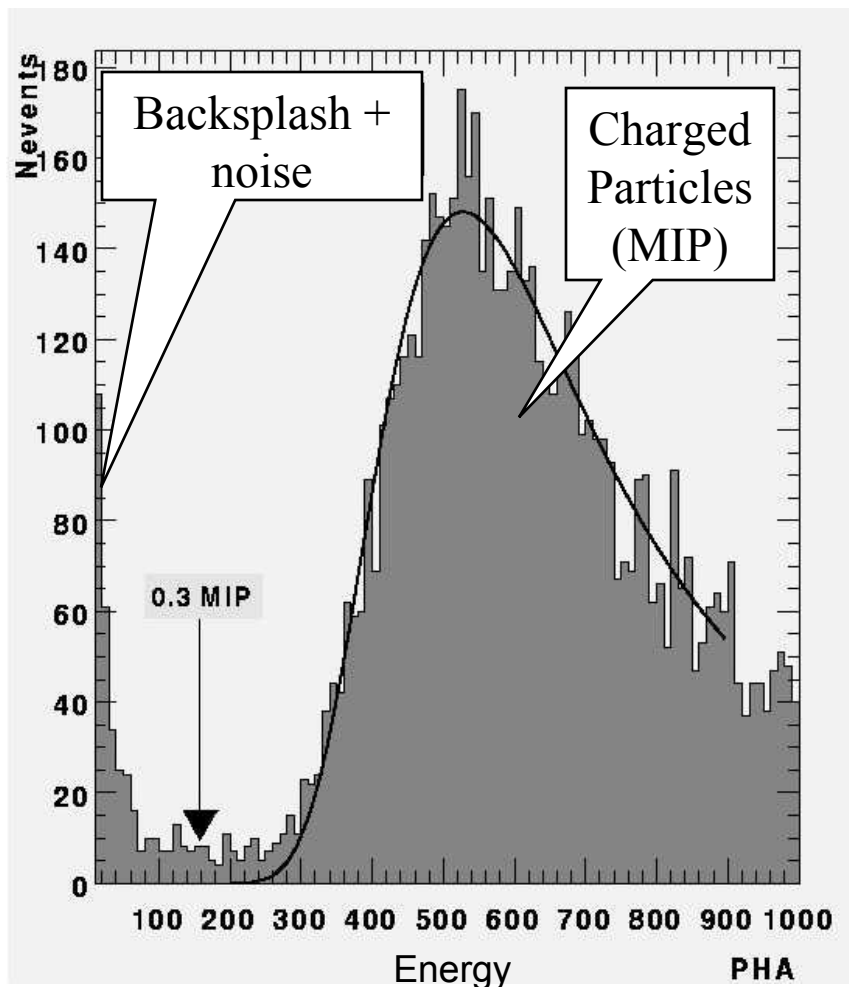
Level III Key Requirements Summary

Reference: LAT-SS-00016

Parameter	Requirement	Expected Performance	Verification Method
Detection of Charged Particles	≥ 0.9997 average detection efficiency over entire area of ACD (less for bottom row of tiles)	≥ 0.9997 ≥ 0.99 (bottom tiles)	Test and Analysis
Fast VETO signal	Logic signal 200-1600 nsec after passage of charged particle	200-1600 nsec	Demonstrate
PHA signal	For each phototube, pulse height measurement for each Trigger Acknowledge (TACK) Below 10 MIP, precision of < 0.02 MIP or 5% (whichever larger) Above 10 MIP, precision of < 1 MIP or 2% (whichever larger)	< 0.02 MIP or 5% < 1 MIP or 2%	Test and Analysis
False VETO rate - backsplash	$< 20\%$ false VETO's due to calorimeter backsplash at 300 GeV	$< 20\%$	Test and Analysis
False VETO rate - noise	$< 1\%$ gamma-ray rejection from false VETO's due to electrical noise	$< 1\%$	Analysis
High Threshold (Heavy Nuclei) Detection	Detection of highly-ionized particles (C-N-O or heavier) for calorimeter calibration.	Yes	Analysis
Size	Outside: 1796 x 1796 x 1050 mm 1806 x 1806 for lowest 310mm Inside Grid: 1574 x 1574 x 204.7 mm Inside TKR: 1515.5 x 1515.5 x 650 mm	1796 x 1796 x 1045 1800 x 1800 at connector 1574 x 1574 x 204.7 1515.5 x 1515.5 x 650	Demonstrate
Mass	< 280 kg	270	Demonstrate
Power	< 31 Watts (conditioned)	14	Demonstrate
Instrument Lifetime	Minimum 5 yrs	> 5 yr.	Analysis



Meeting the Key Requirements



For high-efficiency MIP detection (0.9997), want a low energy threshold.

For good rejection of backslash, want a high energy threshold.

A good balance between these requirements is about 0.3 of the MIP peak energy.

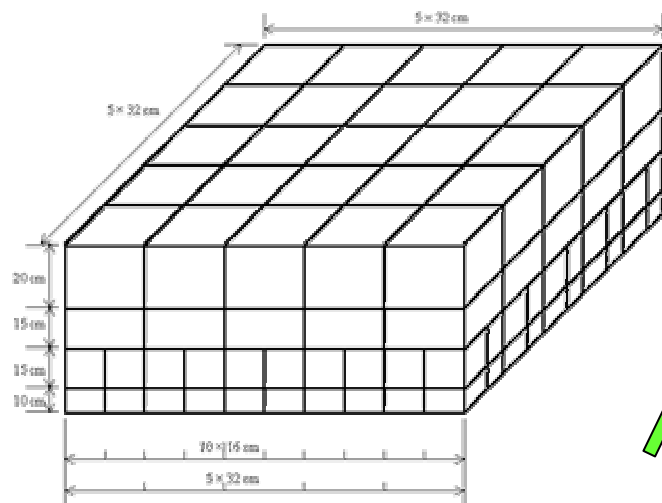
Flowdown - Requirements to Design

Parameter	Requirement	Constraints	Characteristics Needed	Design
Detection of Charged Particles	≥ 0.9997 average detection efficiency over entire area of ACD (less for bottom row of tiles)	Mass Power Size Lifetime Minimize inert material outside active detector	High-sensitivity charged particle detector No gaps Low energy threshold for high efficiency Performance margin to compensate for aging	Plastic scintillator tiles, 1 cm thick, < 1000 cm² size Waveshifting fiber light collection, with clear fibers for transmission in long runs Overlap one dimension, seal other with scintillating fiber ribbons
False VETO rate - backplash	< 20% false VETO's due to calorimeter backplash at 300 GeV	High charged particle detection efficiency Mass Power Size Lifetime	Detector with low sensitivity to soft photons Segmentation < 1000 cm² High energy threshold (backplash is soft)	Photomultiplier tubes, with gain set low at start of mission to allow increase as tube ages. Low-noise electronics Threshold well below MIP peak but above most of backplash

Note that each requirement is in tension with the other.

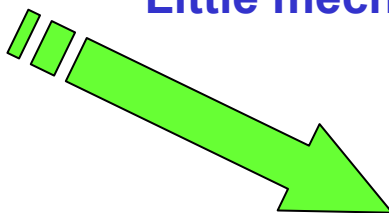


Evolution of the ACD Design



Proposal Design

145 tiles, 290 phototubes each with HVBS
 Stand-alone electronics (ASIC/FPGA/ADC)
 Processed signals sent to LAT electronics
 Little mechanical support for electronics



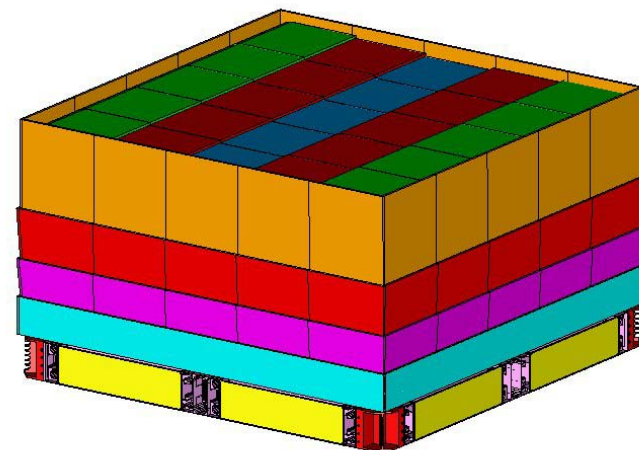
Current Design

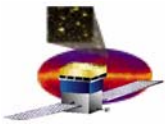
89 tiles, 8 ribbons, 194 phototubes,
 redundant HVBS for each 18 phototubes

Front-end electronics (ASIC/ADC)

Little processing of signals sent to LAT
 electronics

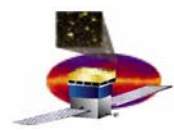
Realistic mechanical support for electronics





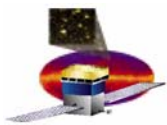
ACD Optimization - Summary

- **Light Collection** - optimized with 5 mm fiber spacing, TETRATEC wrapping material, aluminized fiber ends, multiclاد fibers. Scintillator manufacturer does not matter. Two sets of interleaved fibers for redundant readout.
- **Absolute Efficiency** - using the light collection described above, a single phototube meets the 0.9997 efficiency requirement at 0.3 MIP threshold if there are no appreciable light losses. Light losses in long waveshifting fibers or connector to clear fibers makes the single tube marginal. Fibers were re-routed to shorter paths. With two tubes operating, there is ample margin. The top center row of tiles was thickened to give more light.
- **Broken Fibers** - the ACD could meet its requirements with up to two broken fibers on all tiles.
- **Segmentation** - the 89-tile design meets the backslash requirements.
- **Hermeticity** - a triple layer of square 1.5 mm fibers with offset centers provides adequate sealing of the gaps between tiles. Overlaps were increased to allow for vertical gaps required by acoustic loads.
- **REFERENCE:** LAT-TD-00438-D2



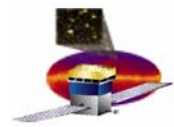
ACD Technical Heritage

- **Plastic Scintillator** - used in all previous gamma-ray telescopes OSO-3, SAS-2, COS-B, CGRO (all 4 instruments), plus many cosmic ray experiments.
- **Waveshifting fibers** - used in GLAST LAT Balloon Flight Engineering Model (BFEM). Waveshifting bars used by HEXTE on RXTE (same material in a different geometry)
- **Photomultiplier tubes** - used in all previous gamma-ray telescopes. HEXTE/RXTE used a commercial version of the same tube we are using (Hamamatsu 4443), and GOLF on SOHO used the same tube as the ACD except for the cathode material (Hamamatsu 4444)
- **High Voltage Bias Supplies** - used in all previous gamma-ray telescopes, plus many cosmic ray experiments.
- **Electronics** - similar ASIC's (same designer) used on the BFEM. Discriminators, PHA and logic signals similar to many flight instruments.
- **Micrometeoroid Shield** - Improved version (more layers, stronger materials) of shield that protected EGRET successfully for nine years.



Reviews – Past and Future

- **Past Reviews:**
 - LAT Internal Review of the ACD – January, 1999
 - Pre-PDR/Baseline Review – February, 2001
 - LAT System Requirement Review (SRR)- May 2001
 - ACD Peer Review – July, 2001
 - 62 RFA's – All closed out
 - LAT PDR/Baseline Review – January, 2002
 - 12 RFA's – All closed out
 - LAT Internal Stanford Linear Accelerator Center Review - April, 2002
 - LAT Delta PDR/Baseline Review - July, 2002
 - 3 RFA's – All closed out
- **Future Reviews:**
 - LAT Critical Design Review (CDR) - April 2003
 - ACD Pre-Environmental Review (PER) – March 2004
 - ACD Pre-Ship Review (PSR) – June 2004
 - LAT Pre-Environmental Review (PER) - February 2005
 - LAT Pre-ship Review (PSR) - July 2005

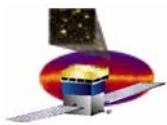


Summary of July Delta-PDR Review

“Subsystem managers have done a very good job of getting the Anti-Coincidence Detector(ACD) ready for this review. All the recommendations from the January 2002 DOE/NASA review were addressed. In particular, a new bottoms-up Work Breakdown Structure was created, contingency and critical path analyses were performed, and Basis of Estimate was provided.

Technical progress has been made on three fronts:

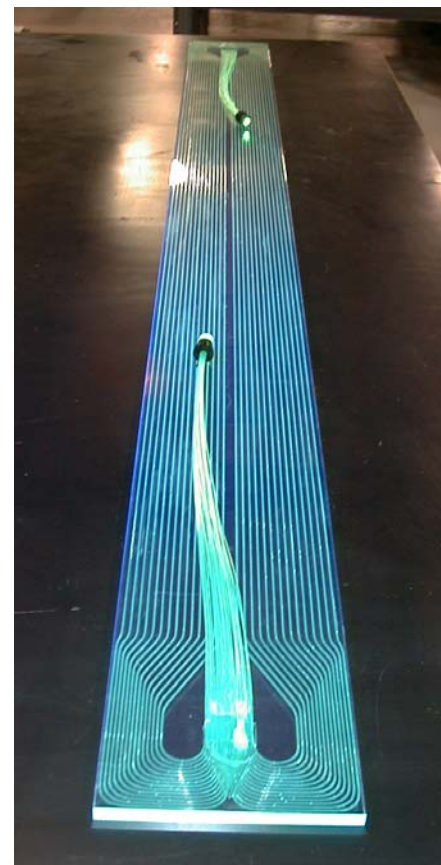
- R&D was continued to finalize layout of the scintillator tile geometry.
- New data was collected during test-beam at CERN to measure backplash effect (self-veto of gamma events).
- Full size mock-up of ACD was built at GSFC to work out details of fiber routing.”



Status of January Review Recommendations

1. Finalize the design and generate the engineering drawings for the tile and fiber layout, including the lowest row of the ACD.

- Designs for the 12 types of tile have been analyzed for thermal and vibration tolerances. Results are being used to generate engineering drawings.
- Design for the lowest tile row has been tested and shown to exceed the requirements.
- Drawings have been made for the routing of the fibers from the tiles to the phototubes. The routing has been checked using a mock-up of the ACD



Prototype tile for the lowest row of the ACD. Testing shows that this design exceeds the 0.99 efficiency requirement.



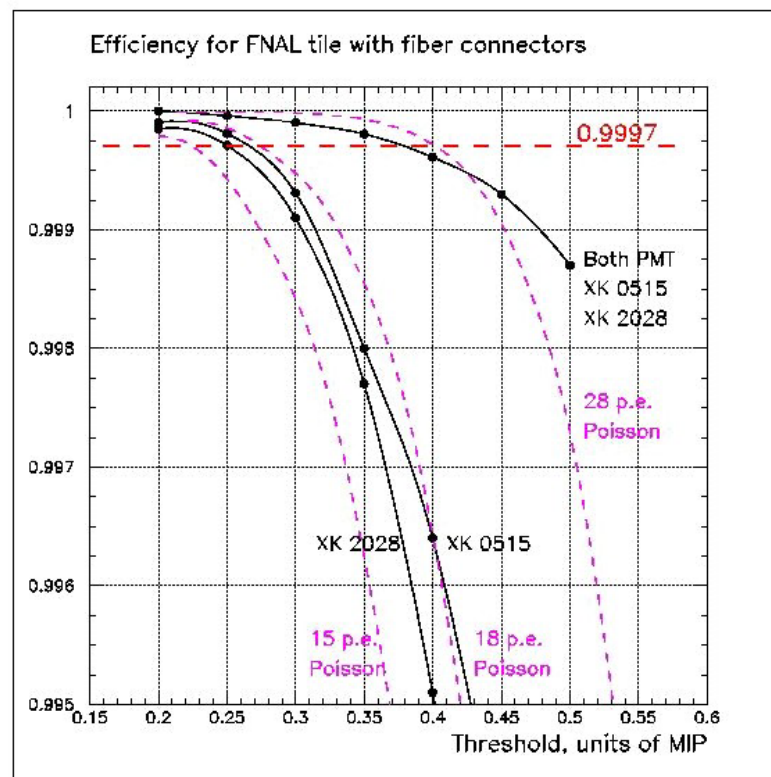
Status of January Review Recommendations

2. Perform light yield tests and muon detection efficiency measurement of the final optical system (scintillator tiles; and fiber ribbons, connector, clear fibers, and photomultiplier tubes).

Complete – results are similar to those shown in January: with two phototubes, 0.9997 efficiency is met; with one phototube, efficiency is ~ 0.999

Light output of Fermilab tiles is good. Light losses in the optical connector and clear fibers were higher than expected. Design improvements were made to compensate for these losses.

LAT-TD-00843-D1, Design Qualification Tests for ACD TDA and Phototubes



Performance of a full end-to-end TDA



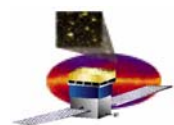
Status of January Review Recommendations

3. Demonstrate that electronic noise of the system is low enough not to affect the muon rejection efficiency and efficiency for gammas by more than one percent.

- Bench tests of the first analog ASICs show no noise problem. Tests on a prototype electronics set (GAFE2 + GARC1) show good separation between MIP and noise signals.
- The ACD electronics noise is required to be $< 0.2 \times$ threshold. The early calculations show that the noise at the lowest threshold setting of 0.1 MIP is approximately 50% lower than the requirement.
- The ACD team along with the LAT Electronics Systems Engineers have developed a grounding and shielding design to keep noise to a minimum.



PHA distribution from qualification phototube, resistor network, GAFE, GARC, and ADC.



Status of January Review Recommendations

4. Complete full mockup of ACD, including clear fiber layout to photomultiplier tubes.

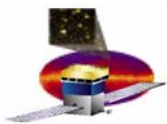
The mockup has been built and fiber routing placements have been completed.



Details of mock-up.



Full-scale mock-up of ACD being used for tile placement and fiber routing from tiles to phototubes. Two bottom tile rows have been included.

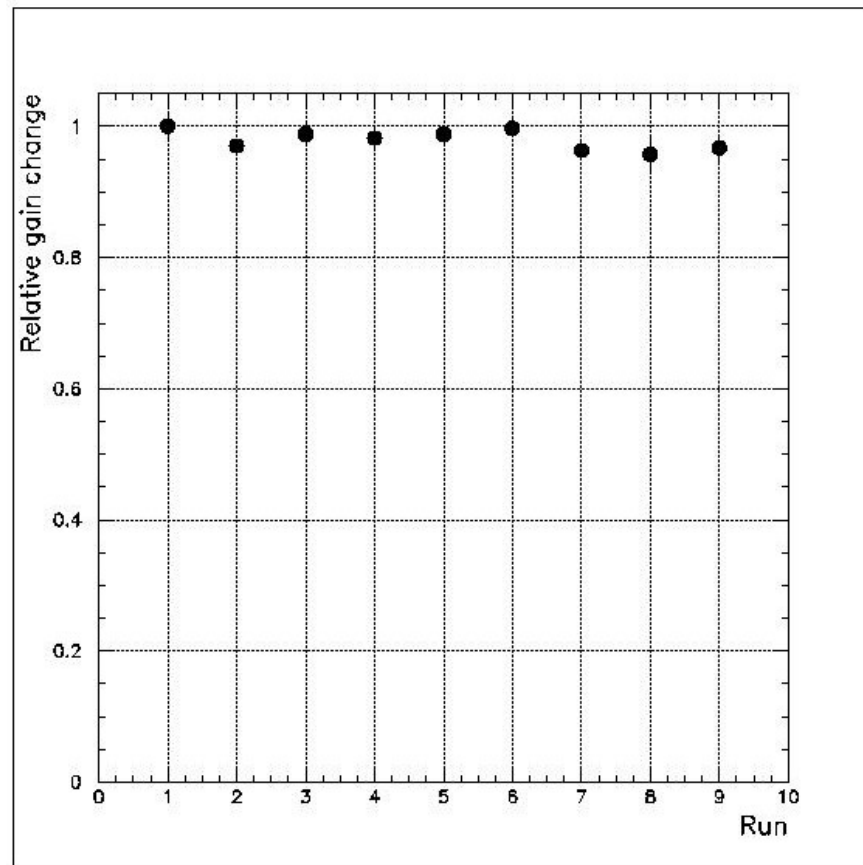


Status of January Review Recommendations

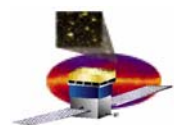
5. Perform thermal cycle of fully assembled tiles and ribbons. Verify that no damage to tile/fiber assemblies takes place and light yield is not decreased.

- Thermal cycle was -65 C to +45 C.
- Performance was measured using a muon telescope for Minimum Ionizing Particles.
- After > 340 cycles, the loss of performance was less than 5%.

**LAT-TD-00858-D1, ACD TDA
Thermal Cycling Test**



Light yield of Tile/fiber assembly during thermal cycling.



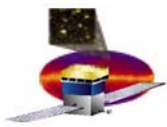
Status of January Review Recommendations

6. Prepare a plan for Quality Control (tile response uniformity and broken fibers) and initial calibration (ADC/minimum ionizing particle) of the ACD system prior to the delivery to the Stanford Linear Accelerator Center.
- Quality Control is covered by the general ACD Quality Plan (ACD-QA-8001).
 - The methods for determining tile response uniformity and detecting broken fibers are documented in “Light Collection/Optical Performance Tests” (LAT-TD-00438-D2). Performance is measured using a muon telescope for Minimum Ionizing Particles.
 - A plan for calibrating the ACD using a muon telescope for mapping reference efficiency and then using internal triggers for PHA distributions is described in “ACD Gain Calibration Test with Cosmic Ray Muons” (LAT-TD-00844-D1). This approach was tested using the balloon flight ACD.
 - Quality plans and acceptance tests for the Tile Detector Assemblies and phototubes have been developed: “ACD Phototube Quality Plan and Acceptance Tests” (LAT-TD-1202), “ACD Tile Detector Assembly Quality Plan and Acceptance Tests” (LAT-TD-1203).

- The current LAT extended schedule incorporates an additional month for ASIC development and additional testing time.
- The GSFC Program management approved qualification and screening process for the ASICs is now shorter than the original one.
- The analog ASIC remains a critical path in the schedule.

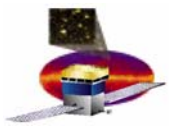


GAFE Veto Generation – 1 MIP



Status of January Review Recommendations

8. Complete the bottoms-up Work Breakdown Structure (WBS) in the Primavera framework. This include a WBS Dictionary and full Basis of Estimate. More than 800 activities in our resource loaded schedule.
- The WBS has been completed and has 10 major elements:
 - 4.1.6.1 Project Management/Systems Engineering/Science
 - 4.1.6.2 Safety and Mission Assurance
 - 4.1.6.3 Tile Shell Assembly
 - 4.1.6.4 Base Electronics Assembly
 - 4.1.6.5 Micrometeoroid Shield/Thermal Blanket Assembly
 - 4.1.6.6 Mechanical Qualification and Calibration Unit
 - 4.1.6.7 Integration and Test
 - 4.1.6.8 LAT Integration and Test Support
 - 4.1.6.9 Mission Integration and Test Support
 - 4.1.6.B Ground Support Equipment and Facilities



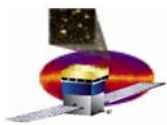
Status of January Review Recommendations

9. **Perform the critical path schedule analysis for the entire subsystem. Provide detailed documentation (at the lowest level of WBS) for the Basis of Estimate of the costs, in particular the on-project and off-project labor costs.**

Two critical paths have been identified (details in a later slide):

- **ASIC development and testing. Four iterations of the analog ASIC is scheduled. Turnaround time from submittal to delivery is typically at least 12 weeks. Adding testing time means that one iteration can take at least four months. Shortened time for the screening testing helps. Scheduled ACD delivery is 9 weeks before the LAT integration need date.**
- **Photomultiplier tube delivery and assembly. The 6-month schedule extension alleviated that pressure somewhat, but the need to have a full set of tubes before assembly still makes this schedule fairly tight.**

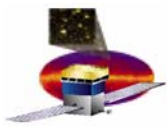
A detailed Basis of Estimate is available. Summaries in later slides.



Status of January Review Recommendations

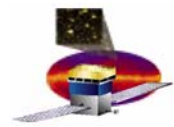
10. Perform the contingency analysis of the subsystem. In particular, assess contingency for the off-project labor tasks.

A detailed contingency analysis, including all aspects of the ACD, has been carried out and incorporated into the PMCS. Some examples of contingency are shown in later slides.



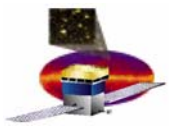
Status of January Review Recommendations

11. Due to lack of a verifiable Work Breakdown Structure (cost estimate) for the ACD, the subsystem is not ready to be baselined at the present time. Consider the following streamlining steps:
 - Separate materials and services from the labor tasks at lowest WBS level
 - Identify all the off-project labor costs at the lowest WBS level
 - Use the actual, fully loaded costs for technicians, specialists, engineers, etc., in all WBS labor estimates
- The PMCS contains this detailed information. Each resource is identified. Summaries are presented in later slides.
- Because the Goddard tax system is based on estimates rather than actuals, the labor costs are not fully loaded.
12. Conduct a Subsystem Baseline Review as soon as the work on the subsystem Work Breakdown Structure is completed.
Review was successfully completed in July.



Status of July Δ PDR Review Recommendations

1. Develop detailed specifications for the readout fibers (light yield, attenuation length, batch-to-batch variations) prior to the bid process and purchase of materials.
 - Material specifications and acceptance requirements are included in the contract with Fermilab, “Fabrication and Assembly Procedure for the Anticoincidence Detector (ACD) Tile Detector Assembly (TDA)”, ACD-PROC-000059. Performed light attenuation measurements on readout fibers from two different manufactures.
2. Ensure that the second generation of the analog ASIC, (to be delivered in August 2002) is well evaluated before third generation is sent off to production.
 - Testing showed problems with the second generation analog ASIC. The third generation, GAFE3, is being tested now, and a fourth generation, GAFE4, is due back later this month.
3. Continue to develop calibration plan for ACD for the Integration and Testing phase.
 - We are continuing to refine the calibration plan, building on our experience with laboratory testing. Example: ACD Functional Test Plans (Comprehensive Performance Test) LAT-TD-01112-D1



GLAST Large Area Telescope:

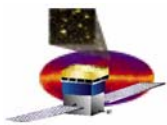
AntiCoincidence Detector (ACD)

WBS 4.1.6

Management

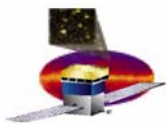
Thomas E. Johnson, ACD Instrument Manager
Thomas.E.Johnson@nasa.gov (301) 286-1284

NASA Goddard Space Flight Center



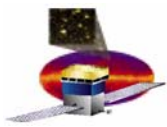
Outline

- **ACD Team Leads**
- **ACD Team Partners**
- **Contingency**
- **ACD Organization Chart**
- **Work Flow**
- **Testing Overview**
- **Fabrication Plan**
- **Schedule**
- **Cost**
- **Procurements**
- **Configuration Management**
- **Micrometeoroid Shield**
- **Issues and Concerns**
- **Summary**



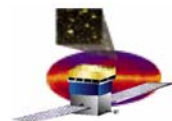
ACD Team Leads

- **Dave Thompson – Scientist, ACD Subsystem Manager**
- **Bob Hartman – Scientist**
- **Alex Moiseev – Scientist**
- **Tom Johnson – Instrument Manager**
- **Mike Amato – Systems Engineer**
- **Ken Segal – Lead Mechanical Engineer**
- **Glenn Unger – Lead Electrical Engineer**
- **Jim La – Integration and Test**
- **Carlton Peters – Thermal Engineer**
- **Andy Eaker – Scheduler**
- **Deanna Adamczyk - Resources**



ACD Team Partners

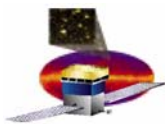
- **Micrometeoroid Shield – Johnson Space Center**
 - **NASA Center of Excellence for micrometeoroid protection**
 - **Eric Christiansen and Jeanne Crews**
- **Tile Detector Assemblies – FermiLab (Department of Energy)**
 - **Experts in fabrication of scintillator detectors**
 - **Phyllis Deering and Todd Nebal**
- **Scintillating Fiber Ribbons – Washington University, St. Louis**
 - **Leaders in scintillating fiber production**
 - **Professor Robert Binns**
- **ASICs - Stanford Linear Accelerator Center (SLAC)**
 - **Extensive experience in ASIC design**
 - **Gunther Haller, Oren Milgrome, Dietrich Freytag**



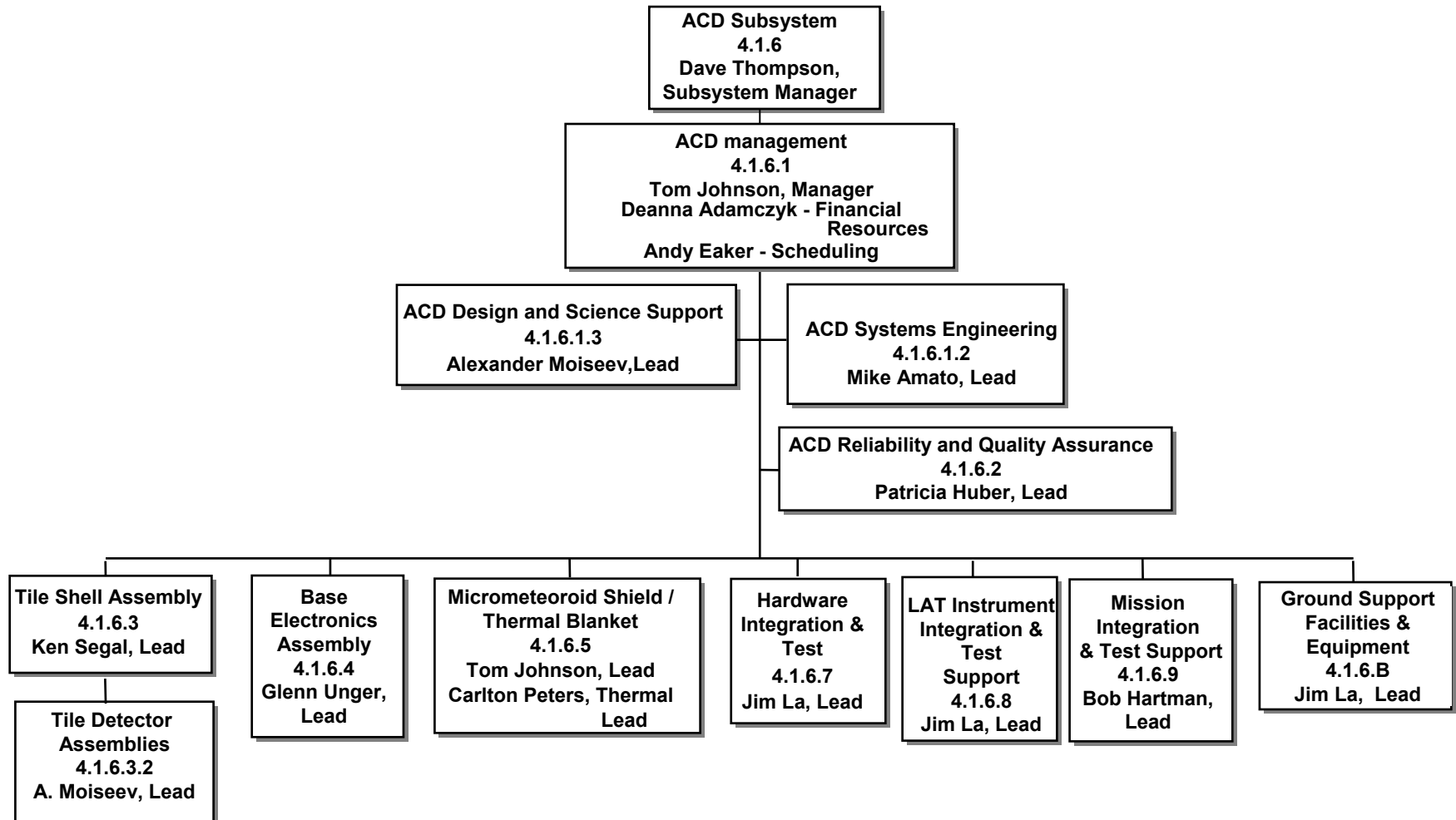
Contingency

- All contingency (mass, power, cost) held at the LAT project level. Change requests are required to account for variance.
- ACD Change Requests Submitted

Change Request #	Description	Status
LAT-XR-770-011	Add Redundant HVBS	Approved
LAT-XR-01009-01	Additional funding for scheduler	Approved
LAT-XR-1200-01	Mass increase from 235 kg to 280 kg	Approved
LAT-XR-01011-01	Analog ASIC cost over run (>\$500K)	Pending
LAT-XR-01119-02	CDR Date Change	Approved
LAT-XR-01192-01	2 Level 3 milestone date changes	Approved
LAT-XR-00557-1	Mass increase from 205 kg to 235 kg	Approved
LAT-XR-01161-01	Micrometeoroid Design & Test (if change in requirements is approved)	Approved
LAT-XR-01001-01	Re-phasing of MPS and Lab Taxes	Approved
LAT-XR-1000-01	FY01 Carryover charges not in PMCS	Approved
LAT-XR-00691-01	New Baseline – April 2002	Approved

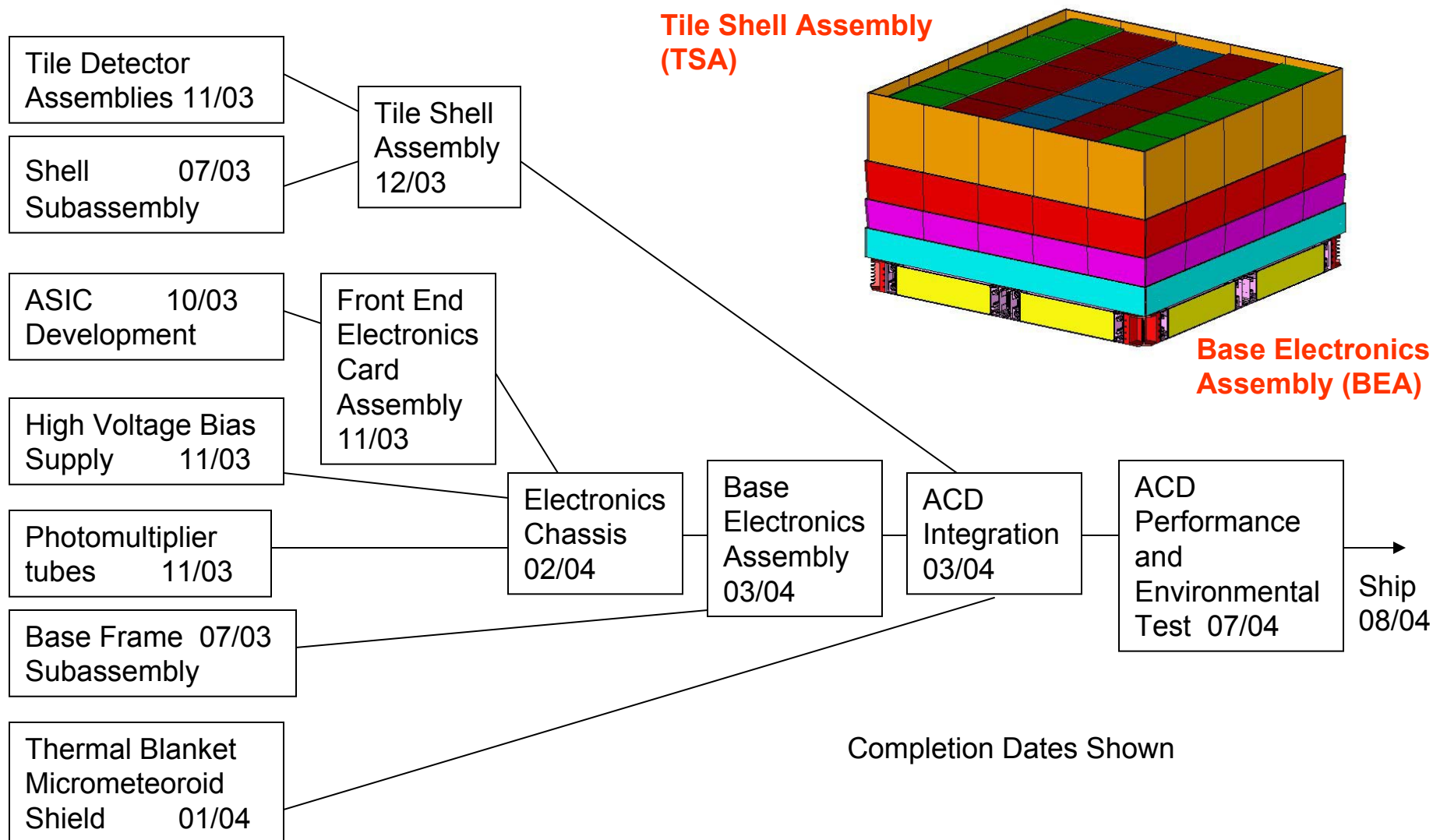


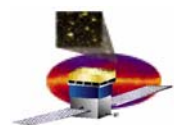
ACD Organization Chart





ACD Work Flow Overview



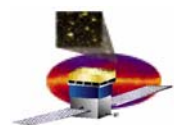


ACD Testing Overview

- Due to size and cost, there is no full-size ACD Engineering Model. The full-size mechanical mockup is used only for fit checks and fabrication of the micrometeoroid shield/thermal blankets.
- Acceptance and Qualification tests, including performance, vibration, EMI/EMC, and thermal vacuum, are carried out at the component and subassembly level. Extrapolation to the full ACD is done by analysis.
- The full protoflight ACD will undergo a complete suite of tests, including absolute efficiency measurement as well as all environmental tests.



Subassembly vibration testing – a section of support shell, composite flexures supporting a scintillator tile, and a micrometeoroid shield/thermal blanket. A similar test included the waveshifting fibers, optical connector, optical fibers, and phototubes.



Development Testing Overview

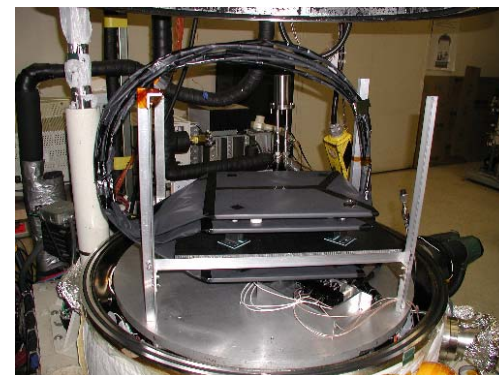


Vibration testing – a section of support shell, composite flexures supporting a scintillator tile, and a micrometeoroid shield/thermal blanket. A similar test included the waveshifting fibers, optical connector, and optical fibers.

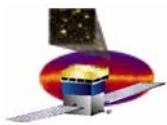
[ACD-PLAN-000032, LAT-ACD Tile Detector Test Vibration Test Plan](#)

Thermal Vacuum testing – a section of support shell with composite flexures, three Tile Detector Assemblies, and four PMT/RN assemblies were exposed to 6 thermal vacuum cycles.

[ACD-PROC-000068, TDA-PMT-Resistor Network End-to-End Thermal-Vacuum Test Procedure](#)



Vibration testing – 4 PMT/RN assemblies with clear fibers connected to 3 TDA's (not vibrated) were subjected to vibration testing.

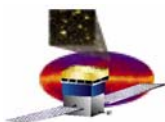


ACD Fabrication Plan

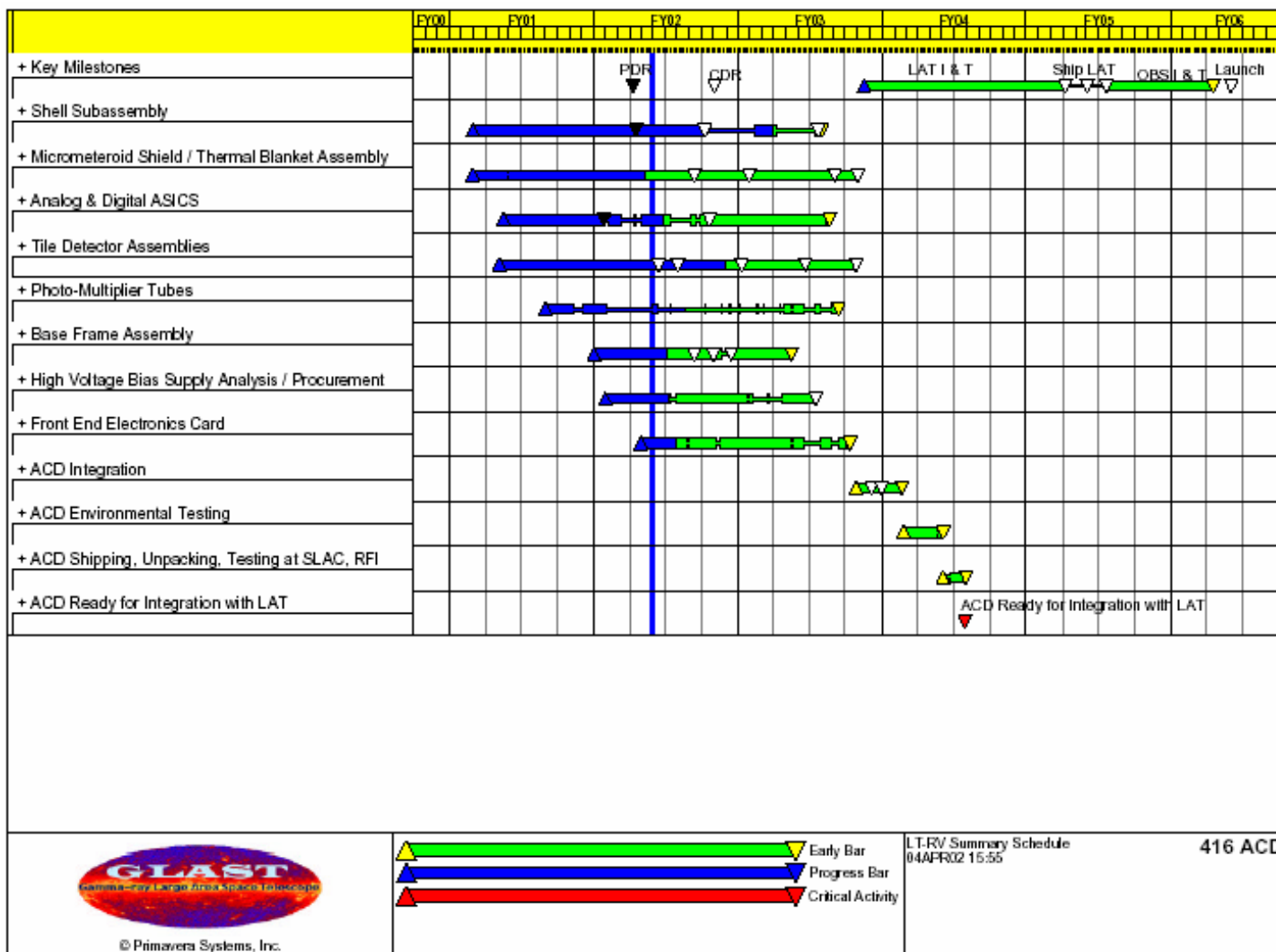
- **Tile Detector Assemblies**
 - **Fermi Lab**
- **Composite Shell**
 - **Panel fabrication performed by outside vender, assembly and test in house**
- **Base Frame**
 - **In house fabrication, assembly and test**
- **Analog and Digital ASIC's**
 - **GSFC/SLAC Design, MOSIS fabrication, GSFC acceptance testing**
- **High Voltage Bias Supplies**
 - **In house design, fabrication by local vender, testing in house**
- **PMT/Resistor Network Assembly**
 - **Procure components and assemble and test in house**
- **Front End Electronic (FREE) Boards**
 - **Procure components and assemble and test in house**
- **Micrometeoroid Shield/Thermal Blanket**
 - **Shield designed by JSC, Blanket designed by GSFC, In house fabrication**
- **ACD Integration and Test**
 - **Building 7, 10, 15, & 29 complex**

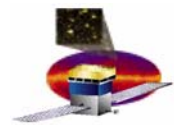


Qualification
phototube in housing
with resistor network.



Top-Level Schedule





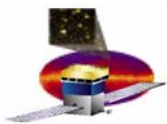
1st Critical Path - Analog ASIC

Activity	Dates
3 rd -5 th Generation Analog ASIC Design	8/22/02-2/13/03
Flight Unit (FU) Analog ASIC submitted to fabrication	2/14/03
FU Analog ASIC Development (fab, package, test, screen)	2/14/03-10/08/03
FREE FU Populate w/Analog ASIC,Digital ASIC, ADC, & DAC	10/17/03-11/13/03
Electronics Chassis FU Pop w/PMT's & Inspect	11/14/03-12/01/03
Electronics Chassis FU Validation Testing	12/3/03-2/2/04
BEA Integration (4 installments)	2/3/04-3/2/04
Install TSA on BEA	3/3/04-3/9/04
Mate & Test Fiber Cables to PMT's	3/10/04-3/16/04
Mate, Install, & Test 4 Lower TDA's	3/17/04-3/18/04
ACD Functional and Performance Testing	3/19/04-4/22/04
ACD Environmental Tests	4/23/04-7/21/04
Shipping to SLAC	7/22/04-8/6/04
Post Ship activities	8/7/04-8/25/04
Schedule Contingency	8/26/04-10/24/04
ACD to LAT Integration	10/25/04



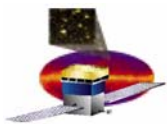
2nd Critical Path – PMT/Resistor Networks

Activity	Dates
PMT Procurement (90 of 240 flight units already received)	10/15/02-6/15/03
Resistor Network procurement, populate, assembly, & test	2/11/03-10/23/03
PMT Integrate and Test with Resistor Network	5/13/03-11/06/03
FREE FU Populate w/Analog ASIC,Digital ASIC, ADC, & DAC	10/17/03-11/13/03
Electronics Chassis FU Pop w/PMT's & Inspect	11/14/03-12/01/03
Electronics Chassis FU Validation Testing	12/3/03-2/2/04
BEA Integration (4 installments)	2/3/04-3/2/04
Install TSA on BEA	3/3/04-3/9/04
Mate & Test Fiber Cables to PMT's	3/10/04-3/16/04
Mate, Install, & Test 4 Lower TDA's	3/17/04-3/18/04
ACD Functional and Performance Testing	3/19/04-4/22/04
ACD Environmental Tests	4/23/04-7/21/04
Shipping to SLAC	7/22/04-8/6/04
Post Ship activities	8/7/04-8/25/04
Schedule Contingency	8/26/04-10/24/04
ACD to LAT Integration	10/25/04



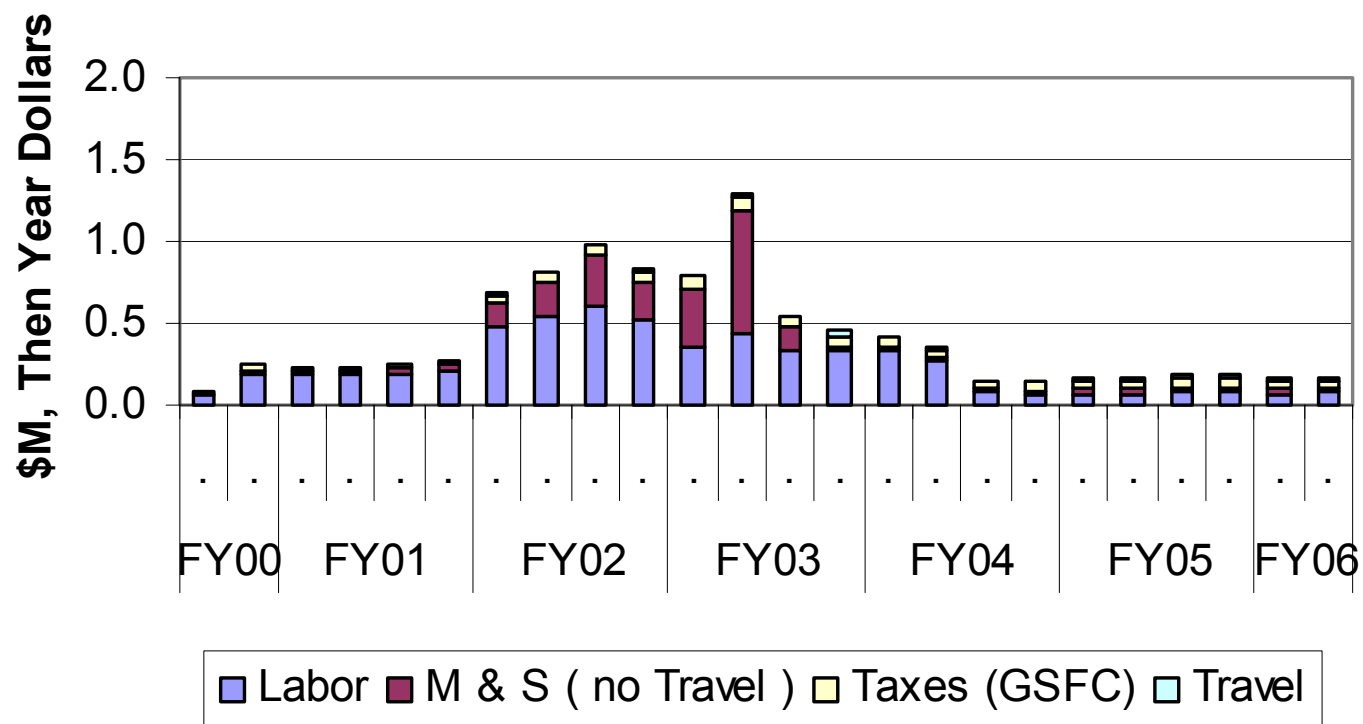
Cost/Manpower Overview by Fiscal Year

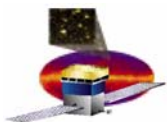
FY	Funding (\$M)	FTE	Activities
2000	0.44	3.4	Planning, test
2001	0.88	7.4	Planning, test, design
2002	3.57	24.3	Complete design, start fabrication
2003	3.33	20.2	Fabrication, assembly, test
2004	1.99	14.1	Integration, test, delivery, LAT support
2005	0.53	4.3	LAT, GLAST support
2006	0.0	1.0	GLAST support
TOTAL	10.74	74.7	



ACD Cost Profile

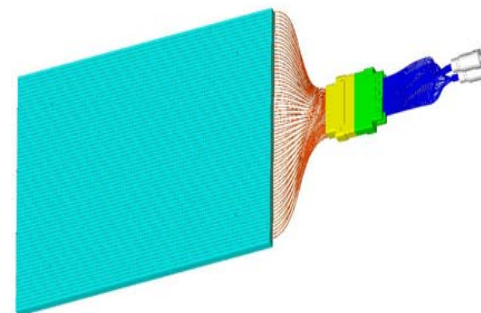
4.1.6 Anticoincidence Detector Cost Type



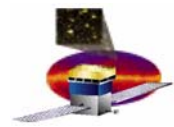


Procurements

- Long lead procurement
 - Photomultiplier Tubes – Have received 90 flight tubes
- Major upcoming procurements
 - Support Shell
 - Tile Detector Assemblies (with fibers)
 - Base Frame
 - Flight ASICs
 - High Voltage Bias Supplies
 - PMT Assembly
- Smaller upcoming procurements
 - Electrical components
 - Tile Detector Assembly mounts

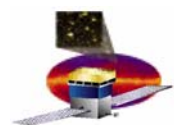


Tile Detector Assembly with
A clear fiber connector



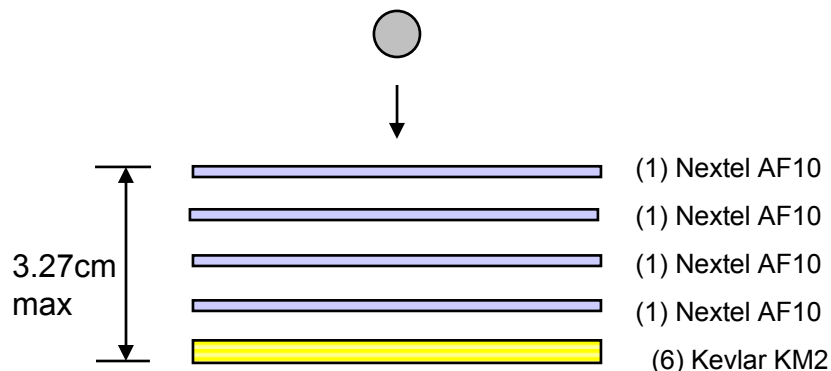
Configuration Management & Information Technology

- **GSFC CM System**
 - **Next Generation Integrated Network – Secure Web based configuration management system. It is a full service CM system with the following services:**
 - **Release and electronically store drawings, procedures, documents, and Work Order Authorizations (WOA's)**
 - **Action Item Database**
 - **Document Library**
- **LAT CM System**
 - **Cyberdocs – Web based document storage.**
- **ACD documents that involve the LAT (i.e. all interface and top level documents) will be placed on Cyberdocs**
- **Lower level ACD Documents, Drawings, and WOA's will be on the GSFC CM System**
- **ACD Website: <http://lhea-glast.gsfc.nasa.gov/acd/>**
 - **Website is used to share information and store draft documents – Used extensively prior to getting the CM system on-line**

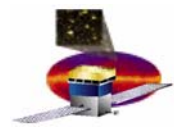


Micrometeoroid Shield Design

- Purpose: To prevent light leaks in Tile Detector Assemblies due to micrometeoroid penetrations
- Analysis and Testing being performed by Johnson Space Center (Eric Christianson & Jeanne Crews)
- LAT-TD-1122.1 – “ACD Micrometeoroid Shield Analysis and Design”
- Current Design based on ORDEM96:



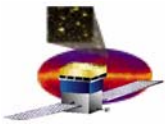
Component	Number in Shield	Thickness each (cm)	Mass per Unit Area each (g/cm ²)	Total thickness (cm)	Total Mass per Unit Area (g/cm ²)
Nextel AF10	4	0.0254	0.025	0.102	0.100
Solimide Foam Spacer	4	0.66	0.0051	2.640	0.020
Thermal Blanket	1	0.32	0.0368	0.320	0.037
Kevlar KM2	6	0.0254	0.023	0.152	0.138
Overall Shield				3.21	0.295



Micrometeoroid Shield Requirements

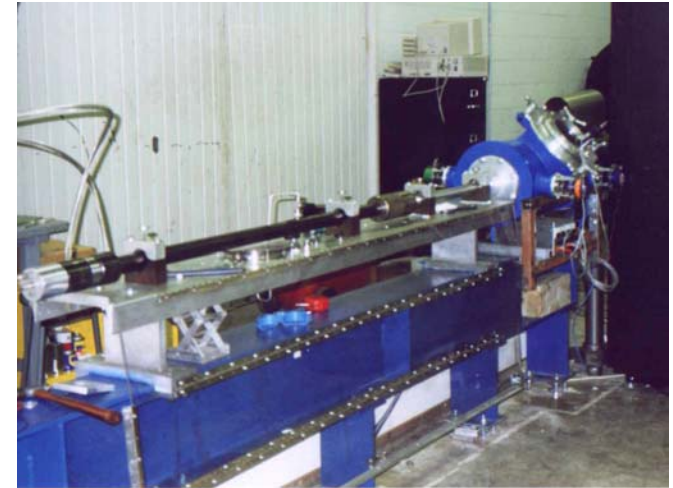
- Requirements are being updated. ORDEM2000 is replacing ORDEM96

Parameter	Requirement	Expected Performance	Compliance
Probability of No Penetration (PNP) over 5 years	95% PNP	ORDEM96: 96.6% PNP ORDEM2000: 86.1% PNP	Y: analysis & test N: analysis & test
Thickness	<3.27 cm	ORDEM96: 3.21 cm ORDEM2000: <3.27	Y: analysis & testing TBD
Areal density	<0.32 g/cm ²	ORDEM96: 0.295 g/cm ² ORDEM2000: <0.32 g/cm ²	Y: analysis & test TBD

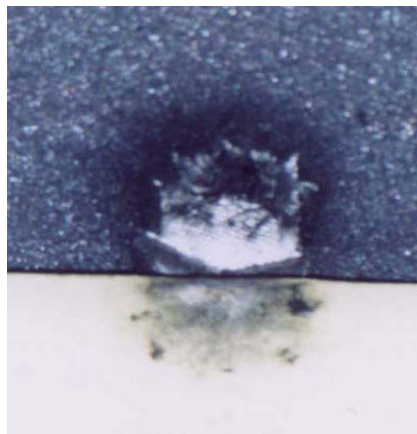


Micrometeoroid Shield Testing

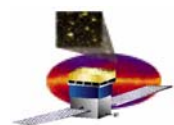
- To measure the difference between models, we took a thermal blanket and wrapped tile with a phototube to Houston (Rice University), combined it with a flight-design shield, and tested it using high-velocity particles at their test facility.
- Testing particles and shields of several sizes, we determined that the existing shield design needs to be improved to enable the Micrometeoroid Shield to achieve its required 95% PNP over 5 years.
- Re-design has been approved (estimate ~\$25K). Waiting on final requirements flowdown from GLAST and LAT before proceeding.



Light gas gun, operated by JSC at Rice University. We tested ~2 mm Al particles at 7 km/s.

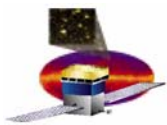


Damage to the interior part of the shield from a 2.2 mm particle. The hole is about 30 mm diameter. The Kevlar backing sheets stopped the debris (this time).



ACD Issues/Concerns

- **The schedule is tight.** The ACD critical path (analog ASIC) has little room for delay. We are drawing on SLAC ASIC experience to minimize risk.
- **There is no ACD Engineering Model.** Although testing will be done on components and subassemblies, the first full-scale test will be on the flight unit.
- **The ACD is not completely redundant.** Loss of a tile, a phototube, or an electronics channel would reduce the ACD efficiency, although risk assessment shows not enough loss to have a significant impact on science.
- **The ACD is dependent on Goddard Civil Service manpower and test facilities.** We have a commitment from Goddard management and fairly high visibility, but crises in other programs have been known to pull manpower away and tie up facilities.



Summary

- **The ACD continues to make technical progress. All the technical recommendations from the January and July reviews have been resolved.**
- **The ACD has developed a coherent, verifiable cost and schedule plan. Basis of Estimate, critical path analysis and contingency have been clarified.**
- **The schedule has two months of float at the end.**
- **The ACD faces no unusual risks. The risks are those experienced by any space flight instrument.**
- **The ACD has an experienced team.**
- **The ACD is ready to proceed with flight hardware fabrication.**